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Control of Salinity

in the Imperial Valley, California

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DECEMBER 1955 **ARS - 41-4**

U. S. Salinity Laboratory, Riverside, Calif.

This publication was prepared at the request of Imperial Valley growers and has been approved by the California Agricultural Extension Service. It is designed to help improve crop yields and reduce losses caused by salinity. It describes common salinity problems, indicates how salt affects crop growth and yields, and tells what to do to eliminate salinity. It recommends management practices that minimize the effects of salinity.

December 1955

ARS-41-4

United States Department of Agriculture
Agricultural Research Service

CONTROL OF SALINITY
IN THE
IMPERIAL VALLEY,
CALIFORNIA

By

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Soil and Water Conservation Research Branch

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What Is Salinity?

Salinity Is Saltiness!

Salty soils usually contain a mixture of salts. A white crust on the surface is an indication of salinity ("white alkali"). This white deposit is usually a mixture of sodium, calcium, and magnesium salts. Moist, dark, oily spots indicate an excess of calcium chloride. All of these salts have one property in common--they dissolve freely in water. Other salts, like lime and gypsum, are only slightly soluble, and do not increase soil salinity appreciably.

Sodium ("black alkali") problems are not common in the Imperial Valley, and are not discussed in this publication. Your County Farm Advisor can help you identify a sodium problem and tell you what to do about it. The most outstanding property of sodium soils is that they take water much more slowly than nearby normal soils. However, in the Imperial Valley, fine texture is a common cause for slow penetration.

Where Do Salts Come From ?

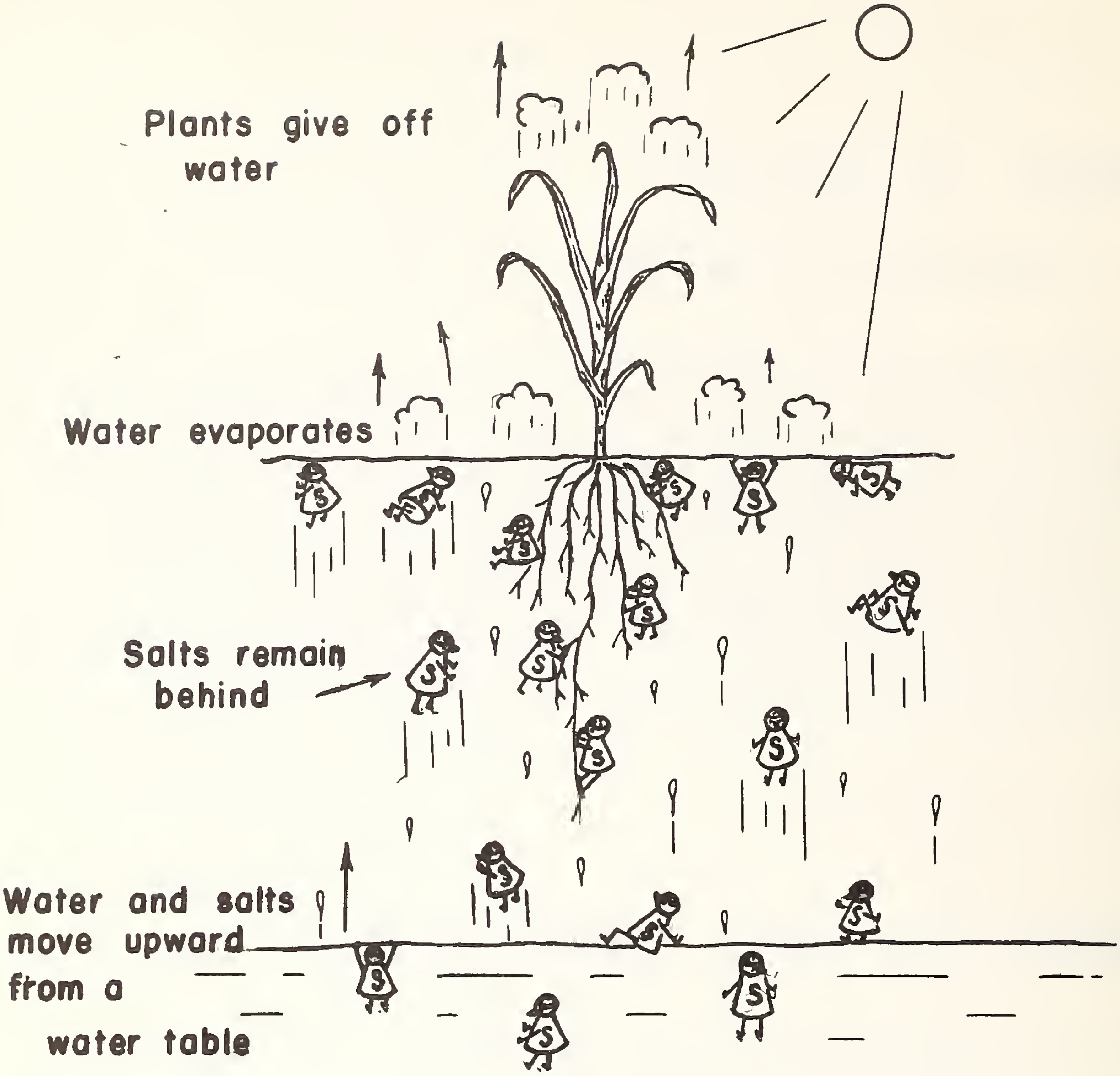
1. From Irrigation Water.

2. From High Ground - Water Tables.

3. From Original Deposits of Salt in Soils.

Irrigation water from the All-American Canal contains about 2,000 pounds of salt per acre-foot of water. If the irrigation water does not penetrate the soil deeply, most of the salt brought in by this water will remain close to the soil surface. If all the salt brought in by canal water remains in the top foot, a good soil can become salty in one crop season.

Ground waters generally contain more salt than irrigation waters. When the ground-water level is close to the surface, a good deal of the salty ground water moves upward as a result of evaporation and plant use. This increases the salt content of the surface soil and may decrease crop growth.



Salts build up in the soil from shallow water tables.

The original source of salts is the rock of the earth's crust. As a result of weathering, the salts are released from the rocks and carried away by water. In dry regions, the salts may be carried only short distances, being deposited in nearby valley soils.

Do You Have a Salinity Problem ?

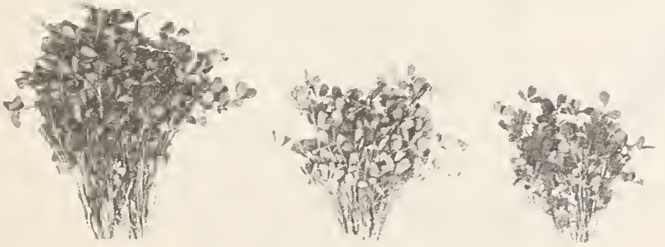
You May Have if You Get :

1. POOR STANDS.

Poor, spotty stands are frequently produced by salty soils because salt delays or prevents the sprouting of seeds. This may occur even though the salt cannot be seen.

2. BARE SPOTS AND UNEVEN GROWTH.

Even if the seed sprouts on salty spots, the young plants may soon die. Irregular bare spots generally surrounded by areas of uneven crop growth are a fairly reliable indication of salinity. The salt crusts may or may not be visible.



3. STUNTED GROWTH AND POOR YIELDS.

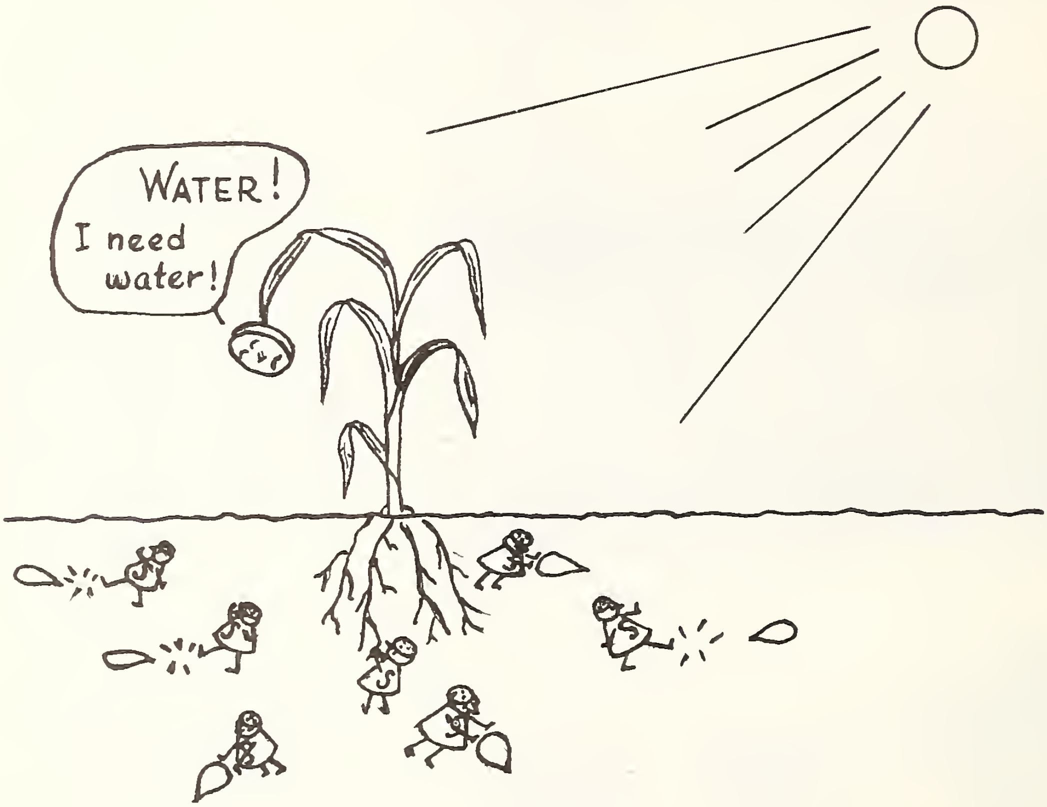
If the salt is evenly distributed in the field, all the plants may be equally stunted and crop yields may be reduced as much as 25 percent without any damage being apparent.

How Does Salinity Affect Plant Growth?

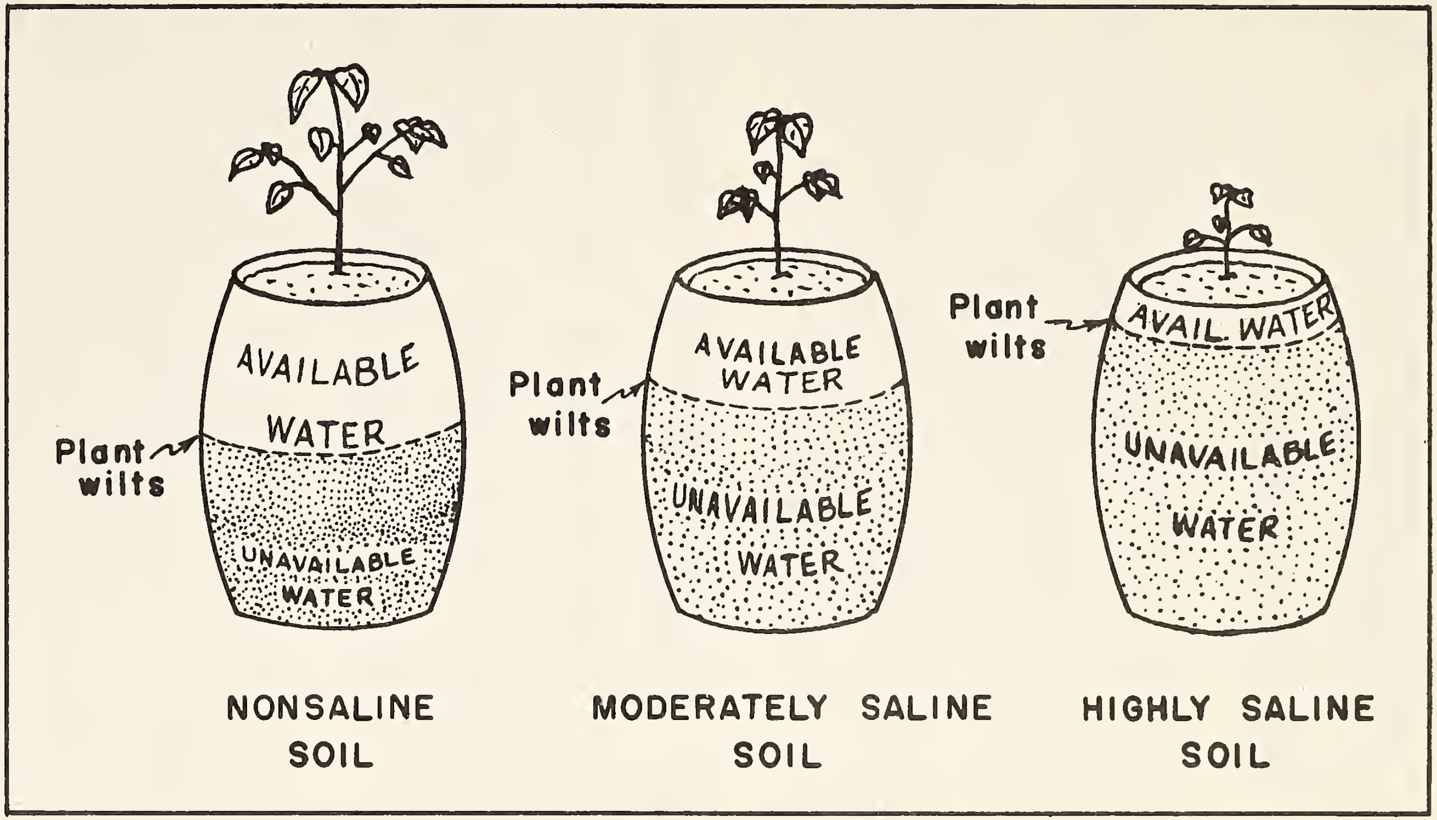
1. By Decreasing the Availability of Water to Plants.

2. By Direct Toxic Effects.

The saltier the soil moisture the harder it is for plant roots to take water from the soil. This decreases plant growth.


WATER!
I need water!

Salts in the soil make it difficult for crops to take up water.



Salts in the soil make water unavailable to crops.

Some salts are toxic and can directly injure or kill plants. Citrus and many other fruit trees may be severely injured by chloride and sodium salts. Boron salts are toxic in extremely small amounts, especially to citrus. Instances of toxicity are rare in the Imperial Valley because Colorado River water does not contain harmful levels of chloride, sodium, and boron.

How Do We Measure Salinity ?

1. By the Electrical Conductivity of the Saturation Extract .

2. By Chemical Analysis.

The saltiness that affects plant growth depends on both the moisture content of the soil and on the amount of soluble salt. A given amount of salt is more injurious in a sandy soil than in a clay loam soil, because sandy soil holds less water and, therefore, produces a saltier solution.

The soil solution is usually obtained by mixing soil and enough water to prepare a saturated soil paste and filtering off the solution. This method takes into account the texture and the water-holding properties of the soil. The saltiness of the filtered solution is most easily measured by its ability to carry an electric current. This ability is called electrical conductivity and is usually expressed in millimhos per centimeter at 25° C. For brevity we use the term millimho.

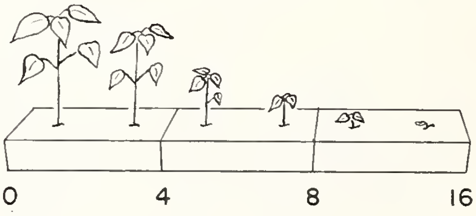
The significance of the millimho as a salinity unit is best understood in relation to its effect on plant growth.

How Does Salinity Affect Different Crops?

Some Are Affected Much More Than Others.

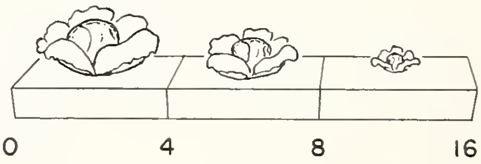
Sensitive crops
like:

BEANS



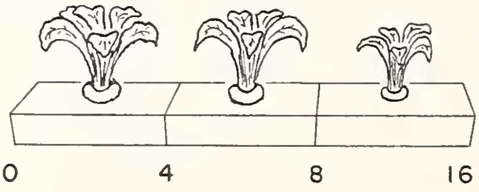
Moderately Tolerant
crops like:

LETTUCE



Tolerant crops
like:

BEETS



SOIL SALINITY (millimhos)

How Can Salinity Be Controlled ?

1. Know the Salinity Status of Your Soil.
2. Use Practices That Prevent Salt Accumulation.
3. Remove Excess Salt.

How Much Salt Is in Your Soil ?

Find Out by Soil Tests.

Very often the grower learns that his field is too salty only after a crop failure. It is cheaper to get this information before planting by making a few simple soil tests. Samples can be analyzed by commercial soil testing laboratories. Your County Farm Advisor can help you in interpreting results and recommending appropriate practices.

Salinity varies with depth and from place to place in a field. At each location samples should be taken from several depths, such as 0-8 and 8-24 inches. Obtain the help of your County Farm Advisor in sampling your field. In selecting locations, he will take into account previous crop history and visible soil differences.

How Can We Prevent Salt Build-up?

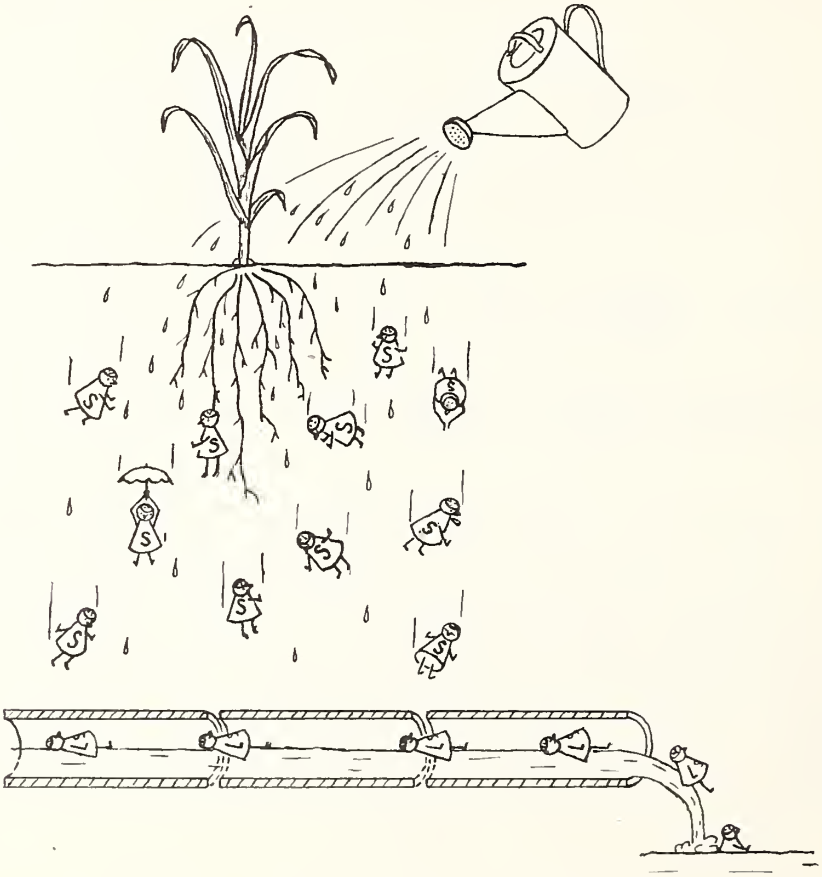
1. Use Proper Irrigation and Management Practices.

2. Provide Good Drainage.

3. Irrigate Adequately.

Good land leveling and irrigation methods help prevent salt accumulation. High spots in a field generally do not receive enough water. This favors the build-up of salts and may result in poor crops. Therefore, high spots should be leveled down and the salt removed by irrigating heavily.

Adequate drainage is necessary for the removal of salt. Shallow water tables bring about salt build-up because ground water moves up and evaporates, depositing salt near the surface. If natural drainage is not adequate, install tile or open drains.



Where natural drainage is not adequate, tiles or open drains assist in removing salts from the root zone.

The water table should be at least 4-1/2 to 5 feet below the surface during most of the crop growing season. Frequent water-table measurements in an open hole at several locations in a field will indicate whether drainage is adequate.

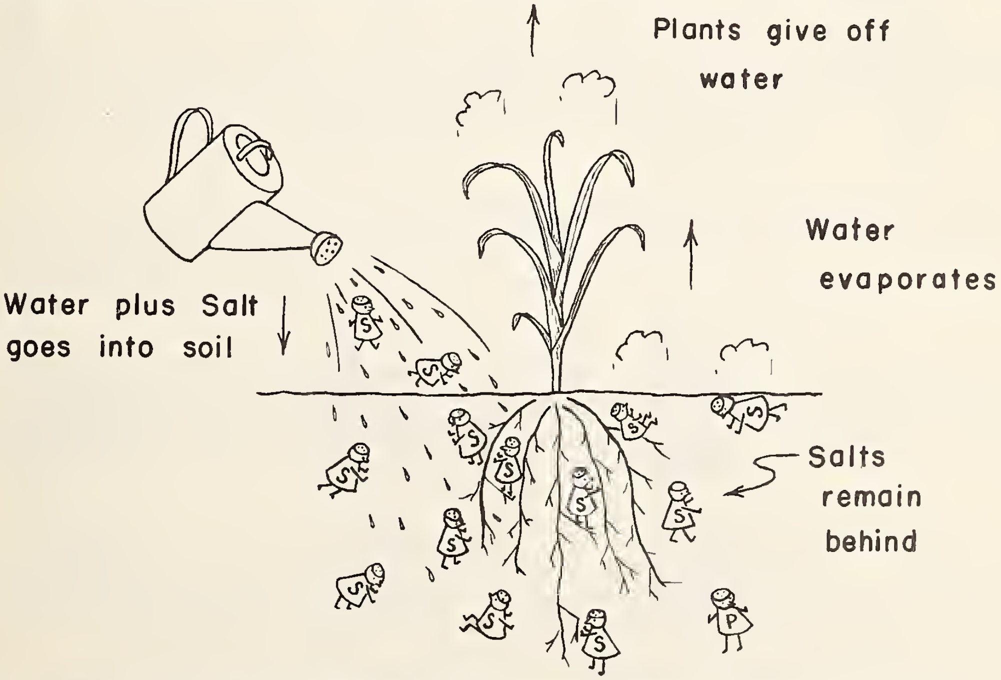
When fields are furrow irrigated, salts are generally leached from under the furrows and build up in the ridges. However, an established crop is generally not affected by the build-up of salt in the ridges since most of the active roots are in the less salty soil under the furrow. On the other hand, adequate flood irrigations in basins or checks do not result in zones of salt accumulation. Light flood irrigations, however, may produce a salinity problem.

In the Imperial Valley, the salt content of the soil generally increases when alfalfa is grown on slowly permeable soils. Because of the possibility of scald during hot weather, water is held on the fields for too short a time to allow adequate penetration of water. Wherever possible, crops should be irrigated with enough water to prevent salt accumulation. For alfalfa, this may be possible only during cool weather.

What Is Leaching Requirement?

The Percentage of Applied Irrigation Water That Must Pass Through the Root Zone.

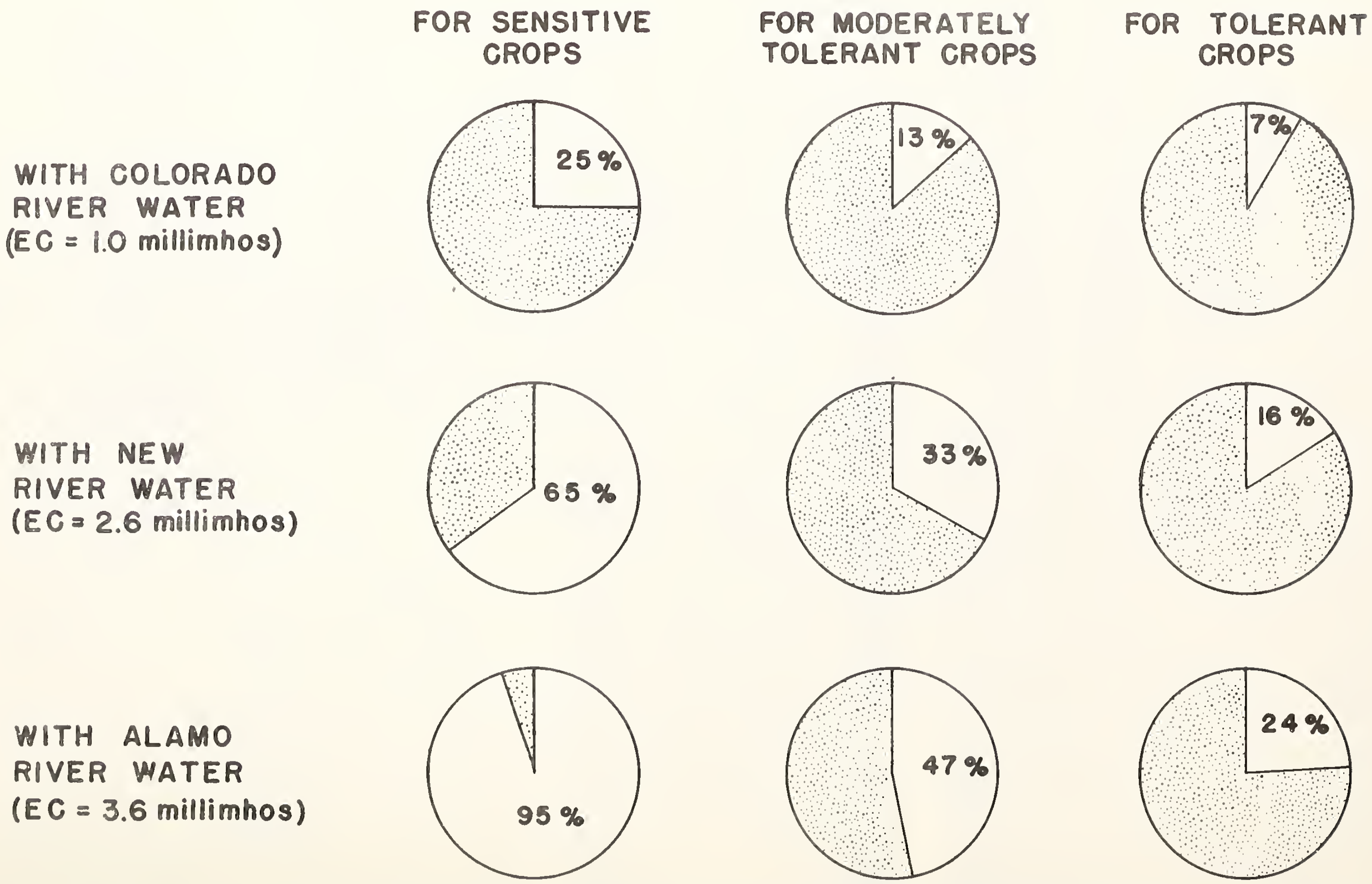
All irrigation waters contain salts. Plants take up water and leave most of the salts behind. Therefore, salts tend to accumulate in the soil.



All irrigation waters contain salts. If only enough water is applied to meet crop needs, salts will build up in the soil.

Salts are kept moving down through the soil by applying more water than the crop uses. The excess water passes through the root zone carrying away the salts. The percentage of applied water that must pass through the root zone depends on the salt content of the water and the salt tolerance of the crop.

LEACHING REQUIREMENTS



The leaching requirement (white area) is the percentage of the irrigation water that must pass beyond the root zone in order to prevent salt build-up. The dotted area represents the water that is evaporated from the soil plus that used by the crop.

Example: If a crop of medium salt tolerance, such as alfalfa, is being irrigated with Colorado River water, 13 percent of the applied water should pass through the root zone to avoid a build-up of salts. This means that if the crop uses 35 inches for the season, then about 5 extra inches should be added, making a total of 40 inches that must penetrate the soil.

Why Do We Leach ?

1. To Reclaim New Lands That Are Salty.

2. To Reduce Salt Accumulations in Crop Lands.

Leaching is the only practical way of removing excess salts from the soil. Salty land may be reclaimed by ponding water in basins. The amount of salt removed depends entirely upon the quantity of water that passes through the soil. The time required for leaching is variable. Some soils leach faster than others because water moves through them more rapidly.

Leaching will be effective only if drainage is adequate. The water must pass through the soil carrying the salt below the root zone and be discharged from the area through tiles or open drains.

Flushing water over the surface is not an effective way to remove salts. Water and salt go into the soil during flushing and very little of the surface salt is carried off the field.

Some irrigation and management practices result in a build-up of salts, especially on slowly permeable soils. If salts have built up in the soil during the cropping season, it may be necessary to pond water and leach occasionally to reduce salinity to a safe level for further cropping.

Salinity may also be controlled by crop rotation. Salts may build up in the soil during the growth of a lightly-irrigated crop like alfalfa. If alfalfa is followed by a heavily-irrigated row crop like lettuce, the salinity will be reduced. In this way the soils can be leached and a favorable salt balance maintained over a long period of time.

How Much Water Is Required To Leach Salty Land?

This Depends on the Salt Content of the Soil and Final Salinity Level Desired.

The salinity level is reduced about 80 percent by leaching with 1 foot of water for each foot of soil. For example, if the average salinity in a 3-foot depth of your field is 40 millimhos and you want to reduce this to 8, then you must leach with 3 feet of water. But if you want to reduce the salinity to 4 millimhos, then 5 feet of water must pass through the soil.

Fifty percent of the salt can be removed by leaching with 6 inches of water for each foot of soil, but to remove 90 percent of the salt, 2 feet of water must be used for each foot of soil to be leached.

In order to determine how much water must pass through the soil for leaching, make salinity determinations of the soil to the bottom of the root zone and apply the above percentage values.

What if We Must Farm Salty Land?

It is sometimes too costly to get rid of salinity, entirely, especially if the irrigation water is of poor quality, or not enough water moves through the soil, or drainage is poor. For best results under such conditions, you should:

1. **Select Crops Tolerant to Your Salt Condition.**
2. **Plant so as to Avoid Salt Build-up Around the Seed.**
3. **Irrigate More Often.**

Which Crops Are Most Salt Tolerant ?

Barley, Sugar Beets, and Cotton.

Crops differ very much in salt tolerance. Except for a few of the tolerant crops, yields drop off as salinity increases so that there is no "safe limit." If, however, small decreases in yield are permissible, then approximate salt tolerance limits can be given.

Plants that can tolerate:

Up to 8-16[1] millimhos	Only up to 4-8 millimhos	No more than 2-4 millimhos
	FIELD CROPS	
Barley, Beets, Cotton	Rye, Wheat, Oats, Sorghum, Corn, Flax	Field beans
	FORAGE CROPS	
Saltgrass Bermuda grass Barley hay	Sweet clover, Dallis grass, Sudan grass, Alfalfa, Tall fescue, Wheat, and Oat hays, Orchard grass, Vetch	White clover Ladino clover
	VEGETABLE CROPS	
Garden beets, Kale Asparagus Spinach	Tomato, Broccoli, Cabbage, Lettuce, Sweet corn, Peppers, Squash, Carrots, Onion, Peas, Cucumber	Radish Celery Green beans
	FRUIT CROPS	
Date	Pomegranate, Fig, Olive, Grape, Cantaloupe	Pear, Apple, Orange, Grapefruit, Plum, Apricot, Peach, Lemon

Within each group, field, forage, vegetable, and fruit, crops are listed in order of decreasing salt tolerance. The values in millimhos at the head of each column give the approximate range of salinity that can be tolerated by the crops in that column.

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[1] Electrical conductivity of saturation extract of the soil.

How Can We Avoid Poor Stands of Furrow-Irrigated Crops?

1. Know the Salinity of Your Soil.

2. Use a Bed Shape That Is "Safe" for Your Salinity Condition, or

3. Leach to Reduce Salinity to a Safe Level.

As water moves up into a bed, salts are dissolved and carried along so that the top of the bed may become very salty. With single-row flat-beds, as little as 4 millimhos in the topsoil at the time of bedding-up may result in excessive salinity.

With double-row beds, most of the salt is carried into the center of the bed, leaving the shoulders relatively free of salt. With this type of bed, no appreciable damage results until salinity in the topsoil exceeds 8 millimhos. If it does, the zone of salty soil in the middle of the bed widens so that even the shoulders of the bed may become salty.

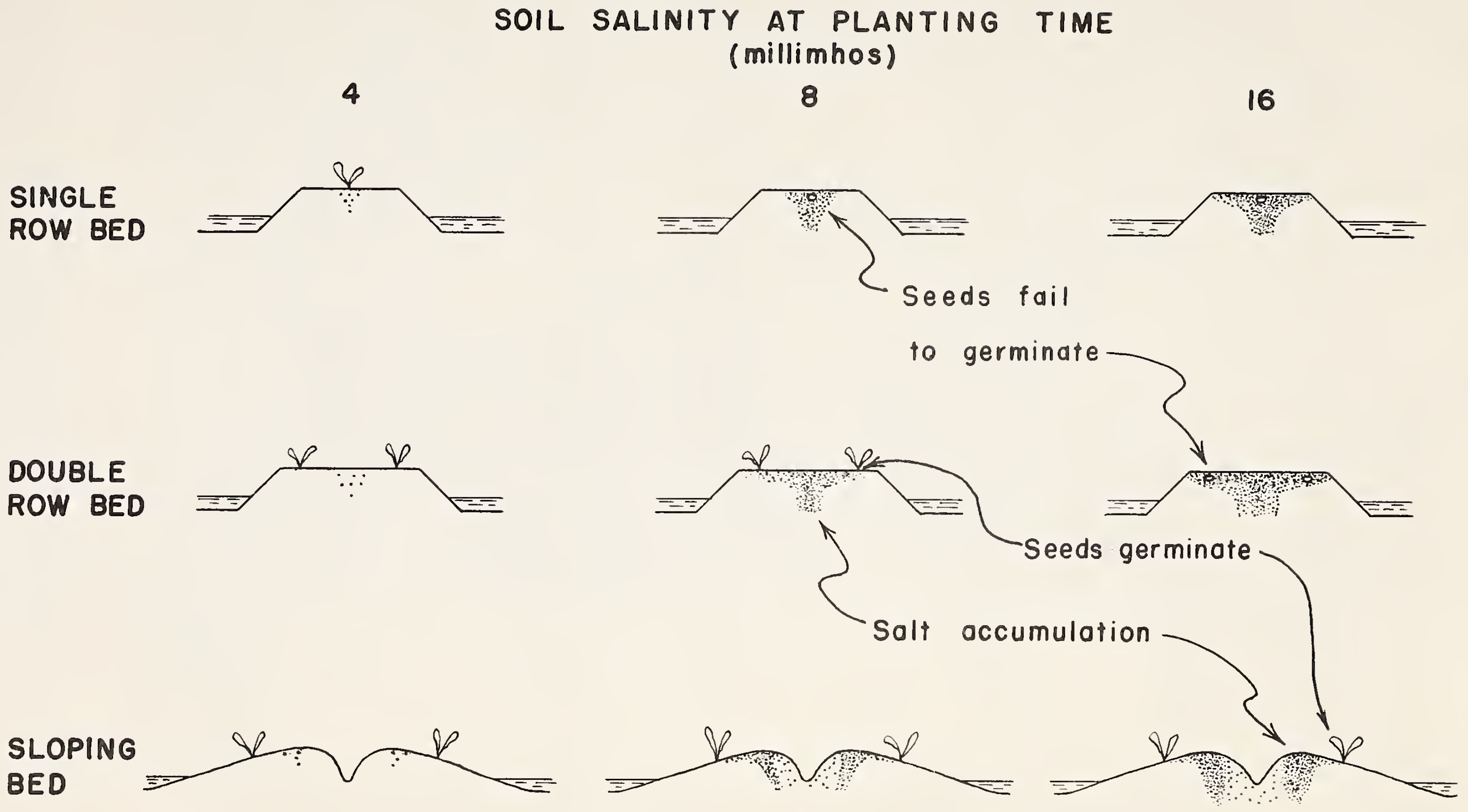
Sloping beds are best on salty soils because seed can be safely planted on the slope below the zone of salt accumulation. Salt is carried away from the soil around the seed instead of accumulating in it.

How Often Should Salty Lands Be Irrigated?

Irrigate More Often Than You Would on Nonsalty Land.

Water is removed from the soil by plant use and evaporation, leaving most of the salt behind. The longer the time between irrigations, the saltier the remaining soil moisture becomes, and the more plants suffer because of water shortage. Because of the salt, plants may need water even though the soil still appears moist. By irrigating more often, we can keep the soil moisture from becoming too salty and thus decrease the harmful effects of the salt on plant growth.

For example, cotton and alfalfa may do well on lands low in salt if irrigated every 15-20 days. But on salty land, the crop will probably yield much better if irrigated every 7-10 days, depending on the degree of salinity.



The pattern of salt build-up depends on bed-shape and irrigation method. Seeds sprout only when they are placed so as to avoid excessive salt build-up around them.

REMEMBER-----

Test. Don't Guess.

Salinity tests can be easily made.

Good Management Pays.

Level properly.
Provide drainage, and leach if necessary.
Select suitable crops and plant properly.
Irrigate adequately.

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